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Description

APPARATUS FOR DAMPING RESONANCE IN A CONDUIT

Cross Reference to Related Applications

[0001] This present application is a continuation patent application of International Application No. PCT/SE02/00260 filed 21 February 2002 which was published in English pursuant to Article 21(2) of the Patent Cooperation Treaty, and which claims priority to Swedish Application No. 0100585-9 filed 21 February 2001. Both applications are expressly incorporated herein by reference in their entireties.

Background of Invention

Field of the Invention

[0002] The present invention relates to an apparatus for damping resonance in a conduit for transporting exhaust gases from an internal combustion engine.

Background

[0003] In most cases, a silencer system consists of one or more chamber(s) with intermediate conduits. The sound pressure inside the conduit will vary with the position along the conduit. Pipe resonance can sometimes occur in an exhaust system and stems from ignition pulses from the engine being reflected between the mouth of the exhaust pipe and a preceding part of the exhaust system, frequently that part being the chamber in the silencer closest to the end pipe. In most cases, this only happens at a specific engine speed, where the wavelength of the ignition frequency coincides with the length between the two adjacent reflecting pipe ends.

[0004] In cases when resonance has occurred in the pipe, the differences in sound pressure will be particularly great between different positions. A high sound pressure then builds up in the end pipe, and sound escapes into the surrounding environment via the mouth to a greater extent than would otherwise have been the case. Known solutions to this problem usually involve the insertion of additional silencer units, which results in higher costs and can also lead to an increase in the pressure drop.

SUMMARY OF INVENTION

[0005] One object of the invention is therefore to produce an ap-

paratus which solves the above-described problem(s), and without appreciably raising manufacturing costs.

[0006] To this end, an apparatus configured according to the teachings of the presently disclosed invention includes a conduit that is provided with at least one perforation located at a distance from the outer end of the conduit. By virtue of this design of the apparatus, an effective reduction in the resonance level is brought about in a simple manner without impacting costs of manufacture in any significant way.

Brief Description of Drawings

[0007] The invention will be described in greater detail below with reference to illustrative embodiments shown in the accompanying drawings, in which:

[0008] FIG 1 shows a diagrammatic plan view of a portion of a conduit designed according to a first variant of the invention;

[0009] FIG 2 is a longitudinal section through a portion of a conduit designed according to a second variant of the invention;

[0010] FIG 3 is a longitudinal section through a portion of a conduit designed according to a third variant of the invention;

[0011] FIGS 4-5 show modifications of the variant of the inven-

tion shown in Fig. 2; and

[0012] FIGS 6-7 show a part of the plate wall of the conduit in a section and a plan view, respectively, illustrating examples of different perforations.

DETAILED DESCRIPTION

[0013] The invention relates to an apparatus that can be applied to exhaust systems and silencer systems in various types of internal combustion engine arrangements, for example engines which function according to the Otto, Diesel or Wankel principles. The engine can be located in a vehicle, for example a passenger car, a truck, a work vehicle, a marine vessel or other type of craft. The invention can also be applied to fixed engine installations, such as engine-driven power plants and the like. The apparatus can then be located in different positions along the pipe portions which form part of the exhaust and silencer systems of the engine. Such a pipe portion can form, for example, the end pipe which transports exhaust gases from a silencer out into the surrounding environment.

[0014] Fig. 1 shows a pipe portion 10, curved essentially at a right angle, with an outlet end 11 and an inlet end 12, the wall 13 of which has a perforation 14 on the inside of the curve. The perforation connects the inner volume of the

pipe to the surrounding environment. When the pipe portion is mounted in an exhaust system, for example as an end pipe, and a pulsating exhaust gas flow passes through the pipe portion, resonance may occur. Some of the sound pressure in this resonance can escape to the surrounding environment via the perforation 14. This means that the size of the resonance is reduced. In this way, the escaping sound, both from the mouth of the outlet and 11 and through the perforation 14, will occur at a significantly lower sound pressure level than would have exited the end 11. Overall, a smaller magnitude sound will be emitted to the surrounding environment from the exhaust system.

[0015] Exhaust emissions through the perforation 14 can be avoided, because the hole is located in a part of the flow passage where the static pressure is comparatively lower than in other parts of the passage.

[0016] Fig. 2 shows on a larger scale an alternative embodiment of the invention in which a number of perforations 14 are made in the pipe wall 13 of a pipe section 10 having a portion 10a with a slightly reduced flow area. In this connection, the flow rate will increase within this portion with a commensurate reduction in static pressure in the pipe

as a consequence. As a result, surrounding air can be sucked into the pipe through the perforations without exhaust gases escaping.

[0017] Fig. 3 illustrates a further variant of the invention, where an indentation 15 has been made in the pipe wall 13 in such a manner that a reduction in the flow area has been brought about in this part. Downstream of the indentation 15, the pipe wall forms a step 16 essentially at right angles out to the normal cross section. A perforation 14 is located on the downstream side of this step. An exhaust gas flow through the pipe section in Fig. 3 will increase its flow rate at the indentation 15. The reduced pressure will draw air in from the surrounding environment of the pipe via the perforation 14.

[0018] Another way of avoiding leakage of exhaust gases via a perforation can be to introduce a partly sound-permeable material which will serve as flow resistance. This material can be applied on the outside of the pipe, inside the pipe or in the perforations themselves. The material can consist of steel, another metal, glass fiber, textile material, ceramic and so forth. The material can, for example, have a structure in the form of a mesk, net, unstructured or structured fabric, and also porous medium.

[0019] Fig. 4 shows a modification of the invention where a conduit designed according to Fig. 2 has been provided with an outer sleeve 17 which covers the perforations and is provided with a large number of small perforations 18. The purpose of the outer sleeve 17 is essentially to "conceal" the perforations 14. The outer sleeve 17 also provides a certain damping of sound leakage via the perforations 14. This leakage can be damped further by virtue of a space 19 between the conduit 10 and the outer sleeve being filled with a suitable damping material, for example mineral wool.

[0020] Fig. 5 shows another modification of the invention where a conduit designed according to Fig. 2 has been provided with an internal cuff made of sound-permeable non-woven fabric.

[0021] As is evident from Figs 6 and 7, the perforations 14 can be made in a number of different ways. The invention comprises a hole which is usually made in a geometrical shape, for example round, square, V-shaped, slot-shaped or any other shape.

[0022] The invention is not to be regarded as being limited to the illustrative embodiments described above, but a number of other variants and modifications are possible within the

scope of the following patent claims. For example, the apparatus according to the invention can comprise a combination of a number of pipe portions 10 arranged in series or in parallel.